of the past and present. It is toward this goal that a group of neurophysiologists are making steady progress; and analysis of membrane noise is but one of the many tools at their disposal.

Ordered disorder?

from P. V. E. McClintock

A NEW theory of the dilute magnetic alloys known as spin glasses has been proposed by Edwards and Anderson. The burden of their argument, published in *J. Phys.* (**F5**, 965; 1975), is that an apparently random arrangement of magnetic spins may, in reality, sometimes be regarded as being highly ordered.

An example of the type of alloy to which their theory applies is formed when a few per cent of manganese is added to copper: the copper, being non-magnetic, serves as a relatively inert medium in which the manganese atoms are held fixed in random spatial positions. The unpaired electron spins responsible for their magnetism are, however, free to point in different directions. At high temperatures the spins will be randomly orientated with their directions changing with time, but the intriguing question arises: what will happen as the temperature is reduced?

In order to try and guess the answer it is instructive, first, to consider what happens in a pure magnetic material, for example pure manganese, where the spins are all equally spaced from each other. In such a case the mutual interactions between nearest neighbour pairs of spins would all be the same, and the system would either become ferromagnetic (all spins pointing in the same direction) or antiferromagnetic (neighbouring spins pointing in opposite directions). Which of these two types of ordered state is the one actually adopted is a sensitive function of the spacing between the atoms. Measurements of the magnetic susceptibility χ as the temperature T is reduced show that the change from the disordered to the ordered state occurs as a so-called cooperative transition, with $\chi(T)$ passing through a sharp anomaly at a critical temperature T_c. This behaviour can be understood if one postulates a critical temperature T_c. This behaviour spins: the larger the number of ordered spins, the larger the molecular field becomes, thus accounting for the sharpness of the anomaly and also, of course, for the description of the transition as cooperative.

On the other hand, when the manganese is diluted with copper, the magnetic atoms will no longer be spaced equally from each other, and the whole situation becomes very much more complicated. The simple molecular field approach is no longer applicable because some pairs of spins will be attempting to align while others, with different mutual separations, will be tending to take up antiparallel orientations. Moreover, the different spin spacings will tend to give rise to different values of the temperature T_c at which the ordering transition occurs. Thus, common sense would seem to suggest that any peak in $\chi(T)$ must be greatly broadened. Experiments, however, have demonstrated quite otherwise: Canella and Mydosh (*Phys. Rev.*, **B6**, 4220; 1972) for example, working on the somewhat similar iron–gold system, found that for an alloy containing 5% of iron there was a very sharp cusp in $\chi(T)$ at about 20 K.

To try to account for this, Edwards and Anderson have pointed out that, despite their random positioning, there must be some configuration of the orientations of the spins which minimises their potential energy. Considering the spins' positions in space to be fixed and permanent, this configuration can then properly be regarded as the ground state of the system (in fact, one of many such states, each corresponding to a local minimum in potential energy). The authors argue that the mere existence of such a state is sufficient to give rise to a well-defined magnetic ordering transition, and hence to account for the observed sharp cusp in $\chi(T)$. Thus, as T is reduced, there must eventually come a temperature at which the spins 'notice the existence' of this ground state; and, as $T \rightarrow 0$, the system will then settle into that state. Of course, if one were able to examine the material in its ground state, it would seem, superficially at least, still to be in total disarray with the spins arranged quite randomly. The randomness would be more apparent than real, however, because the system would be in the particular state which minimised its potential energy. It thus could reasonably be regarded as being, in actual fact, highly ordered.

These ideas are by no means original, other workers having previously arrived at broadly similar conclusions. The great contribution which Edwards and Anderson make in this paper is that of devising a theoretical framework within which the magnetic behaviour of such systems may be treated quantitatively. They describe the degree of order in the spin system by a parameter q which represents the probability that a spin pointing in a particular direction at one moment will be pointing in that same direction when viewed again a long time later. Thus at $T=0$, where the system is magnetically in a state of perfect order, $q=1$; while for $T \geqslant T_c$, there is no long-range order, and $q=0$. The order parameter q therefore behaves rather like the molecular field of the familiar Curie–Weiss theory. The authors have, in fact, worked out these ideas at a similar level of accuracy to that of the Curie–Weiss theory, and they suspect that their conclusions must be inaccurate in similar ways, notably in a wrong prediction of the detailed shape of the cusp in $\chi(T)$: they are generously leaving the application of quantum mechanical refinements to other workers.

Their main conclusion, however, is the important one: that, even though the alloy may be neither ferromagnetic nor antiferromagnetic, it will nevertheless undergo a magnetic ordering transition which should manifest itself as sharp peaks in properties such as the magnetic susceptibility, and at a temperature which can in principle be predicted. This is a remarkable theoretical result, but one which is in excellent accord with reality as revealed by the experiments.

Mutating and mapping SV40

from Lois K. Miller

NUCLEIC acid biochemists are now able to manipulate the DNA genome of small animal tumour viruses with remarkable skill as illustrated by two papers from Paul Berg's laboratory (Shenk *et al., Proc. natn. Acad. Sci. U.S.A.*, **72**, 989; 1975; and Carbon *et al., Proc. natn. Acad. Sci. U.S.A.*, **72**, 1392; 1975). These workers have exploited the known specificities of several types of DNA nuclease to produce viral deletion mutants and map those mutants with astounding ease, accuracy, and rapidity.

Mutations in small animal viruses are difficult to map by the more conventional genetic methods because of their size, low recombination frequencies, and lack of different mutant types for three-factor genetic crosses. A technique, originally developed for ΦX174 (Weisbeek *et al., Biochim. Biophys. Acta*, **224**, 328; 1970; Hutchison and Edgell, *J. Virol.*, **8**, 181; 1971), was modified by Lai and Nathans (*Virology*, **60**, 466; 1974), and utilised to map temperature sensitive (ts) mutations of SV40. The technique relies on the ability of wild-type DNA fragments to rescue a mutant DNA genome when the two are properly annealed together and introduced to an appropriate cell. When wild-type restriction endonuclease fragments are employed, the mutation can be localised within a single fragment and the relative position within the genome is known since restriction nuclease fragments can be ordered by independent means. Al-